Curriculum Vitae of Luís M. A. Bettencourt

Office Address
CCS-3 Los Alamos National Laboratory
MS B256 Los Alamos NM 87545
Tel: 1-505- 667 8453 Fax:1-505 - 667 1126
E-mail: lmbett@lanl.gov Web: `www.c3.lanl.gov/~lmbett`

Home Address
701 East Alameda, 3
Santa Fe NM 87501, USA
Tel: 1-505-920 6220 (cell)

Education and Research Experience

• Los Alamos National Laboratory Los Alamos, NM, U.S.A.
March 2003 – present
Technical Staff Member at the Computer and Computational Science Division [CCS-3]

• Massachusetts Institute of Technology Cambridge, MA, U.S.A.
December 2000 – present
Senior Postdoctoral Associate at the Center for Theoretical Physics.

• Los Alamos National Laboratory Los Alamos, NM, U.S.A.
March 2000 – March 2001
Slansky Fellow at the Theoretical Division (This is a distinguished postdoctoral position rewarding interdisplinary research at the Theoretical Division of LANL).

• Los Alamos National Laboratory Los Alamos, NM, U.S.A.
November 1997 – March 2000
Director Funded Postdoctoral Fellow at the Theoretical Astrophysics (T6) and Condensed Matter and Statistical Physics (T11) groups.

• Heidelberg University Heidelberg, Germany
October 1996 – November 1997
Postdoctoral Position at the Institute for Theoretical Physics.

• Imperial College, University of London London, U.K.
October 1992 – September 1996
Ph.D. in Theoretical Physics, 31st of December 1996.
Title of Thesis: *Symmetry-Breaking Phase Transitions in the Early Universe.*
Supervisor: Dr. R. J. Rivers.

• Instituto Superior Tecnico Lisbon, Portugal
September 1987 – July 1992
Undergraduate degree (5 years) in Engineering Physics with (the equivalent of) First Class Honors. Undergraduate dissertation: *CP-Violation and B-Physics*

Publications

37. "The self-consistent bounce: an improved nucleation rate" with Yoav Bergner, hep-ph/0308107. To appear in Physical Review D.

36. "Dressing Up the Kink", with Yoav Bergner, hep-th/0305190, To appear in Physical Review D.

35. "Tipping the balances of a small world", cond-mat/0304321.

34. "From boom to bust and back again: the complex dynamics of trends and fashions", cond-mat/0212267, submitted to Physical Review E.

33. "A step beyond the bounce: bubble dynamics in quantum phase transitions", with Yoav Bergner. To appear in Physical Review D.

32. "The role of point-like topological excitations at criticality: from vortices to global monopoles", with Nuno D. Antunes and Martin Kunz. Published in Physical Review E **65**, 066117 (2002).

31. "Hydrodynamic scaling from the dynamics of relativistic quantum field theory", with F. Cooper and K. Pao. Published in Physical Review Letters **89**, 112301 (2002).

30. "Vortex description of the first order phase transition in type-I superconductors", with G. Stephens. To appear in Physical Review E.

29. "Nonequilibrium Langevin evolution of disoriented chiral condensates", with K. Rajagopal and J. Steele. Published in Nuclear Physics A **693** 825 (2001)

28. "Spontaneous vortex formation in the cooling dynamics of gauge systems", with G. Stephens and W. H. Zurek. Published in Physical Review Letters **88** 137004 (2002).

27. "Dynamical behavior of spatially inhomogeneous relativistic $\lambda\phi^4$ quantum field theory in the Hartree approximation", with K. Pao and J. Sanderson. To appear in Physical Review D **65** 025015 (2002).

26. "The electrical conductivity in high temperature QED", with E. Mottola. Published in Proceedings of "Strong and Electroweak Matter 2000", Ed. C. Korthals-Altes.

25. "Topological excitations and second order transitions in 3D O(N) models". Invited lecture, published in the proceedings of "Topology of strongly correlated system", Eds. J. Bicudo *et. al.*

24."The role of topological excitations in continuous phase transitions". Invited contribution to *Fluctuating Paths and Fields, Festschrift Dedicated to Hagen Kleinert on the Occasion of His 60th Birthday* (World Scientific, Singapore, 2001).

23. "Properties of scalar field Langevin and Fokker-Planck equations and their application to the dynamics of second order transitions". Published in *Physical Review D* **63** 045020 (2001).

22. "The Ginzburg regime and its effects on topological defect formation", with N. D. Antunes and W. H. Zurek. Published in *Physical Review D* **62** 065005 (2000).

21. "Shards of broken symmetry", with W.H. Zurek, J. Dziarmaga and N.D. Antunes. Les Houches Lectures of NATO A.S.I., in *Topological defects and the non-equilibrium dynamics of symmetry-breaking phase transitions'*, Eds. H. Godfrin and Y. Bunkov. Published in *Acta Phys.Polon. B* **31** 2937 (2000).

20. "Thermal motion of a single vortex in a Bose-Einstein condensate", with R. Sasik and S. Habib. Published in *Physical Review B* **82** 2824 (1999).

19."Controlling one-dimensional Langevin dynamics on the lattice", with S. Habib and G. Lythe. Published in *Physical Review D* **62**, 1238 (2000).

18. "Predicting the critical density of defects in O(N) scalar field theories.", with N. D. Antunes and A. Yates. Published in *Physical Review D* **64** 065020 (2001).

17. "Vortex String Formation in a 3D U(1) Temperature Quench", with N. D. Antunes and W. H. Zurek. Published in *Physical Review Letters* **82** 2824 (1999).

16. "The Length Distribution of Vortex Strings in U(1) equilibrium scalar field theory", with N.D. Antunes. Published in *Physical Review Letters* **81** 3083 (1998).

15. "Time Evolution of correlation function for classical and quantum anharmonic oscillators", with C. Wetterich. Electronic Archive Number hep-ph/9805360.

14. "Time Evolution of Non-Equilibrium Correlation Functions", with C. Wetterich. Published in *Physics Letters B* **430** 140 (1998).

13. "Thermodynamics of Cosmic String Densities in $U(1)$ Scalar Field Theory", with N. D. Antunes and M. Hindmarsh. Published in *Physical Review Letters* **80** 908 (1998)

12."Non-intercommuting Cosmic Strings", with P. Laguna and R. M. Matzner. Published in *Physical Review Letters* **78** 2066 (1997).

11. "The Dynamics of Symmetry Breaking Phase Transitions", with N. D. Antunes. Published in the *Proceedings of Sixth International Parallel Computing Workshop*, Kawasaki, Japan, November 1996.

10. "Multiple-Scale analysis of the Quantum Anharmonic Oscillator", with C. Bender. Published in *Physical Review Letters* **77** 4114 (1996).

9. "Out Equilibrium Dynamics of Symmetry Breaking and Topological Defect Formation", with N.D. Antunes. Published in the *Physical Review D* **55** 925 (1997).

8."Multiple-Scale analysis of Quantum Systems", with C. Bender. Published in the *Physical Review D* **54** 7710 (1996).

7. "Non-equilibrium Evolution of Field Theories" with N.D. Antunes. Published in the *Proceedings of Fifth International Parallel Computing Workshop*, London, U.K., September 1995.

6. "Winding Number Correlation Functions and Cosmic String Formation", with T.S. Evans and R. J. Rivers. Published in the the *Physical Review D* **53** 668 (1996)

5. "Subcritical Bubbles and other Non-perturbative Configurations in the Electroweak Phase Transition". Published in the *Proceedings of Fourth Workshop on Thermal Field Theories and Their Applications*, Dalian, P. R. China, August 1995.

4. "Coarse Grained Fluctuation Probabilities in the Standard Model and Subcritical Bubbles". Published in the *Physics Letters B* **356** 297 (1995).

3. "Interactions Between Local $U(1)$ Cosmic Strings: an Analytical Study.", with R.J. Rivers. Published in the *Physical Review D* **51** 1842 (1995).

2. "Non-intercommuting configurations in the collisions of U(1) type I Cosmic Strings", with T.W.B. Kibble. Published in *Physics Letters B* **332** 297 (1994).

1."The Role of Local Defects in Cosmological Phase Transitions: Interacting Cosmic Strings". Published in the *Proceedings of Third Workshop on Thermal field Theories and Their Applications* , Banff, Alberta, Canada, August 1993.

Invited Lectures and Colloquia

1. **Invited Speaker** at "Social organization and scaling" international meeting of ISCOM [information society as a complex system] at the Santa Fe Institute, August 2003.
2. **Invited speaker** at CNLS Conference on Mathematical Epidemiology "Computational and Mathematical Approaches to Homeland Security, Public Health Policy and Control: Challenges Posed by Emerging and Reemerging Diseases", LANL, July 2-3, 2003
3. **Invited seminar** at CNLS [LANL] seminar series: "From boom to bust and back again : the complex dynamics of trends and fashions", June 2003.
4. Physics Department **Colloqium** at the University of Montreal, Canada, 18th of January 2002.
5. **Invited speaker** at International conference on "Topology of strongly correlated systems", Lisbon, Portugal, Oct. 8-13, 2000.
6. **Lecturer** at the Los Alamos Summer School, Los Alamos, NM, June-August 2000.

In addition I have given over 30 **invited seminars** in leading research universities and laboratories in the USA, Canada and Europe.

Grants and collaborations at Los Alamos National Laboratory

1. I co-wrote, with W.H. Zurek (T6), an **IHPCI** proposal entitled '**Phase Transitions in the Early Universe and their analogues in the laboratory**' for the use of the bluemountain open cluster. As a result we were awarded \$ $30K$. The proposal can be

viewed at `http://qso.lanl.gov/~lmbett/prop_front.html`.

2. Together with W.H. Zurek (T6) I co-wrote a proposal for a **University of California Research Partnership** (UCRPI) with the Group of Prof. Chiao in U.C. Berkeley, entitled '**Photon superfluid as a complex adaptative medium; Critical phenomena and spatial solitons in non-linear cavities**'. As a result we were awarded $\$ 55K$/year per institution, for 3 years. This experiment together with the theoretical work we are developing will reveal light behaving as a non-linear field theory which exhibits critical phenomena and in particular can develop an analog of superfluidity.

3. My work with W.H. Zurek (T6) on the evolution of vortex strings under a temperature quench was **featured on an informative poster on the Avalon** T/CNLS Dec-α massive parallel computer cluster as one of its two early **scientific success stories**.

Awards and Educational Fellowships

1. Chosen (with 50 others) out of over 200 applications (by essay) to **participate in the Computer Research Association international conference** on "Grand Research Challenges in Information Security and Assurance", Airlie House, Warrenton, Virginia, November 16-19, 2003. The conference aimed at creating the vision of the Computer Science research community of the challenges and opportunities facing computer networks over the next decades. A list of 4 "Grand Challenge" problems was produced as the result, see `http://www.cra.org/Activities/grand.challenges/security/home.html`

2. **Awarded a Portuguese National Science Foundation (JNICT) Post-graduate Fellowship**, 1992–96, to conduct Postgraduate studies leading to my PhD degree.

3. **Awarded a Fellowship for Young Researchers** between 1990–92 by **INIC**, the *Portuguese National Institute for Scientific Research* , while an undergraduate at IST. The research was conducted at the Institute for Physics and Mathematics in Lisbon and resulted in my Undergraduate dissertation entitled *CP-Violation and B-Physics*.

4. **Winner of Essay Competition for young Europeans** (European Union wide) sponsored by the Japanese Ministry of Foreign Affairs on cooperation between Japan and E.U. Countries, August 1989. The prizes were a 20 days study trip to Japan, together with the winners from other European countries, organized by the Japanese Ministry of Foreign Affairs.

Graduate supervision and teaching experience

As part of the opportunities during my education and Postdoctoral positions I have undertaken undergraduate and more recently graduate teaching and advising:

1. Set up **MSc final research project** on "Decision Theory, and the dynamics of trends" for students at Imperial College, University of London, academic year 2003/04 under the supervision of Dr. R. J. Rivers.

2. **Graduate student research supervision at MIT-CTP**.
Supervised Graduate student Yoav Bergner's thesis on the non-equilibrium time evolution of first order phase transitions in quantum field theory. Yoav successfully defended his thesis in August 2003.

3. **Supervisor for Summer Student at LANL**.
This is a Summer graduate program in which students have a change to experience research at LANL. June-August 1999.

4. Tutor at B.U.S.S.T.E.P., **British Universities Summer School in Theoretical High Energy Physics** University of Sussex, Falmer, U.K. September 9-24, 1997. Tutors are selected among promising senior postdocs to cover the materials in the school's syllabus. These reflect the perceived basic and new exciting fields of high energy Physics and Cosmology. My field of expertise was non-equilibrium quantum fields.

5. Teaching Assistant in **Dynamical Systems and Chaos**
Imperial College, London, England. October 1994-January 1995.

6. Teaching Assistant in **Quantum Mechanics**
Imperial College, London, England. October 1993-January 1994.

7. Teaching Assistant in **Thermodynamics**
Instituto Superior Tecnico, Lisbon, Portugal. February 1992-July 1992.

8. Teaching Assistant in **Classical Electrodynamics**
Instituto Superior Tecnico, Lisbon, Portugal. October 1991-January 1992.

I have also assisted with final examinations for Physics undergraduates at the University of Heidelberg, between October 1996 and November 1997.

Other Scientific Activities

1. I **Organized the weekly T6-Tea seminars at the Theoretical division, LANL**. These are an informal seminar/discussion meetings for LANL scientists (especially T6) and visitors to present and discuss their recent work.

2. **Referee** for Physical Review Letters, Physical Review A, Physical Review D, Physical Review E, Physics Letters A, Annals of Physics, Physics of Plasmas, Journal of Statistical Physics and Quantum and Classical Gravity.

3. **Scientific Secretary** of **School** and **A.S.I.** in *Current Topics in Astrofundamental Physics*, Erice, September 1994.

4. **Assistant Coordinator** of **A.S.I.** in *Electroweak Physics and The Early Universe*, Sintra, March 1994.

Language Proficiency

I have native proficiency in Portuguese and English. I have fluent communication skills in Spanish, French and German and good oral proficiency in Italian.

Algorithmic and Computational Experience

As part of my research I developed reliable numerical methods and diagnostics for studying the dynamics of many different nonlinear systems and for extensive data analysis. In particular I have great experience in solving large sets of nonlinear partial differential equations in very demanding circumstances, *viz.* under stochastic or applied driving fields, and when conservation laws or constraints must be satisfied.

I am also very familiar with several methods for Monte Carlo sampling of distributions, molecular dynamics, nonlinear reaction-diffusion, large nonlinear eigenvalue problems and the use of cluster algorithms for the characterization of networks and correlations based on methods of percolation theory, to cite only a few examples.

As a result of tackling these problems I have gained experience in algorithms and programming in **fortran90, c and MPI in massively parallel computers**. I have used the **Fujitsu AP1000** at the Imperial College Centre for Parallel Computing, the **CrayT3E** at the Technical University of Berlin and more recently the **Avalon Dec-α cluster** at the Theoretical Division/CNLS and the **Nirvana supercomputing platform** both at Los Alamos National Laboratory.

I also know Unix/Linux, OS X, PERL, HTML and several different data analysis, plotting and symbolic manipulation platforms: Mathematica, Maple, some MATLAB, Data Explorer, supermongo, gnuplot.